

A Survey of Sharpshooters (Hemiptera: Cicadellidae) in Virginia Vineyards, a Region of Expanding Concern for Pierce's Disease¹

Anna K. Wallingford² and Douglas G. Pfeiffer

Department of Entomology, Virginia Tech, 216 Price Hall, Blacksburg, Virginia 24061, USA

J. Entomol. Sci. 47(4): 360-365 (October 2012)

Abstract A survey was conducted during the 2006 and 2007 growing seasons to record the presence of sharpshooters (Hemiptera: Cicadellidae) vectors of Pierce's disease in *Vitis vinifera* L. growing regions of Virginia. *Oncometopia orbona* (F.) and *Graphocephala versuta* (Say) were consistently trapped in all regions and throughout each growing season, the latter trapped in the highest number. Peak flight of both species occurred early in the season, the time of greatest concern for introduction of infection. Peak flight of *O. orbona* occurred earlier than that of *G. versuta*. *Homalodisca insolita* (Walker) was trapped in the Coastal Plain of Virginia; this is the most northern record of this species to date.

Key words Pierce's disease, sharpshooters, *Oncometopia orbona*, *Graphocephala versuta*, *Homalodisca insolita*

Pierce's disease is a vascular disease of grapes caused by the xylem-limited bacterium *Xylella fastidiosa* (Wells). The causal agent is transmitted by sharpshooters (xylem-feeding Cicadellidae; Frazier and Freitag 1946), and by some froghoppers (Cercopidae; Severin 1950). Vine decline occurs when xylem fluids are blocked by proliferation of bacterial colonies as well as by plant response to infection (Hopkins 1989, Newman et al. 2003, Stevenson et al. 2005). In mild climates, vine death can occur within 2 - 3 yrs of initial infection (Gubler et al. 2006).

The primary mode of *X. fastidiosa* transmission to grapevines is through sharpshooter feeding (Purcell et al. 1979, Almeida and Purcell 2006). There is little to no latent period between the insect acquiring bacteria and being able to transmit it to a new plant so infection is often seen in those vines within close proximity to infected ones (Severin 1949, Almeida and Purcell 2003). Because sharpshooters overwinter as adults and *X. fastidiosa* can be retained in the mouthparts, the first wave of sharpshooters that emerge in the spring are able to transmit the disease (Freitag and Frazier 1954, Myers et al. 2007). Bacterial colonies are not passed to offspring; therefore, new generations of sharpshooters must feed on infected host plant tissue before becoming a vector themselves (Freitag 1951). Because bacterial colonies are held only on the mouthparts, bacterial colonies are lost with each molt (Purcell and Finlay 1979).

Pierce's disease is a limiting factor in European bunch grape (*Vitis vinifera* L.) production in the southeastern United States, and Virginia lies on the northern edge

¹ Received 24 February 2012; accepted for publication 30 April 2012.

² Corresponding author (email: awalling@vt.edu).

of this range. The causal agent is present in all grape-growing areas of the state (Wallingford et al. 2007); however, inland regions are thought to be at low risk of chronic infection as cold winter temperatures prevent chronic bacterial infection of vines (Feil and Purcell 2001). There is concern for Pierce's disease in the midAtlantic states as these winter conditions are less consistent from year to year, and because susceptible varieties, like Chardonnay, Cabernet Franc, Cabernet Sauvignon, represented the majority of bunch grapes grown (Raju and Goheen 1981).

Here, we present a survey of sharpshooter vectors within Virginia vineyards and identify the most abundant sharpshooter species in Virginia vineyards as *Graphocephala versuta* (Say) and *Oncometopia orbona* (F.). We also seek to gain temporal information on the movement of these 2 species into vineyards during the grape-growing season.

Materials and Methods

Ten commercial vineyards were monitored for presence of sharpshooter insects using yellow sticky traps. Two vineyards were monitored in each of 5 geographical regions of Virginia (Fig. 1) growing several varieties of European bunch grapes and representing a range of typical vineyard edge habitats (e.g., deciduous forest, pasture land, residential, agricultural). Yellow sticky traps (22.9 × 27.9 cm unbaited Pherocon AM; Trécé Inc., Adair, OK) were suspended from vineyard training wires, 1 m off the ground, and replaced approx. every 2 wks, April–October 2006 and March–October 2007. Trapping began 1 month earlier in 2007 because sharpshooters were captured in April 2006 traps, indicating earlier activity than anticipated. Traps were examined under a dissecting microscope, and sharpshooters were identified to subfamily or species (when possible), counted and preserved in ethanol for systematic identification by the USDA Systematic Identification Laboratory (Beltsville, MD). Voucher specimens are located in the Virginia Tech Insect Collection (Blacksburg, VA).

Because sharpshooter feeding behavior and movement are directed by vine phenology (Mizell and French 1987), trap collection numbers were associated with growing degree days accumulated by the beginning of each trapping period. Growing degree

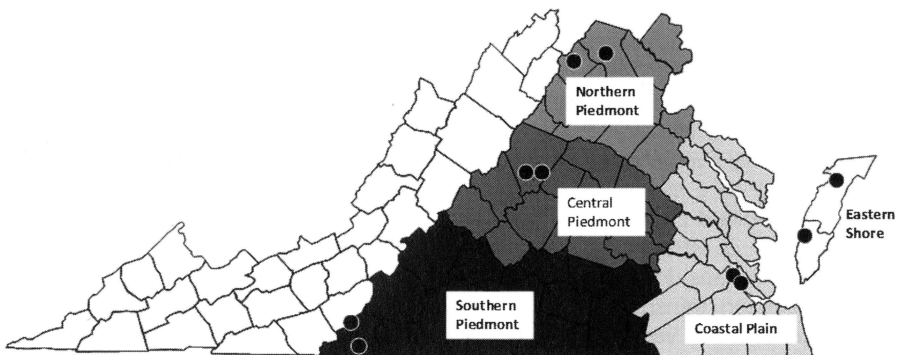


Fig. 1. Locations of vineyards surveyed for sharpshooters in 2006 and 2007.

days (GDD) after January first were calculated from daily minimum and maximum temperatures collected from the nearest NOAA weather station for each location, using 10°C minimum threshold, 32°C maximum threshold.

$$\text{GDD} = ((T_{\text{max}} + T_{\text{min}})/2) - 10^{\circ}\text{C}$$

A Student's *t*-test was conducted using JMP (SAS Institute Inc. 2007) to test for significantly greater number of GDD accumulated at each site by peak flight of *O. orbona* versus that of *G. versuta* and also to test for significant difference in total number of individuals trapped during peak flight ($n = 10$, $\alpha = 0.05$).

Results and Discussion

Pierce's disease vectors were present in every grape-growing region of Virginia, and their presence is recorded in the beginning of the growing season, the most susceptible time for introduction of *X. fastidiosa*. Several species of known and potential Pierce's disease vectors were trapped at every collection site in 2006 and 2007 (Table 1). The most consistently trapped species were *G. versuta* and *O. orbona*; these 2 species made up the largest percentage of all potential vector species trapped. *Homalodisca insolita* (Walker) was trapped in the Coastal Plain in 2007 and has been observed in yellow sticky traps in subsequent studies in the same region. This is the most northern record of this species, a congener to glassy-winged sharpshooter (*H. coagulata*) which is the primary native vector species of Pierce's disease in states south of North Carolina (Almeida and Purcell 2003).

Both *O. orbona* and *G. versuta* were first trapped by grapevine bud break in early April in 2006 and 2007. Peak capture of *O. orbona* occurred mid-May to end of June, but this species was rarely trapped after July. Peak capture of *G. versuta* occurred June through August and was observed in traps throughout the season until the end of the collection period. Peak capture of *O. orbona* occurred earlier than that of *G. versuta*; growing degree days accumulated at peak capture of *O. orbona* was less than that of peak capture of *G. versuta* in both years (Table 2). More *G. versuta* were trapped than *O. orbona* in both years (Table 2).

Only one peak in insect density was seen for each species although laboratory populations of both *O. orbona* and *G. versuta* were found to complete at least 2 and 3 generations per year, respectively (Turner and Pollard 1959). It is possible that subsequent generations migrate to other host plants outside of vineyard space. The timing of peak flights may indicate that the *O. orbona* trapped in the vineyard at peak flight are mainly overwintered individuals. It is possible that those *G. versuta* trapped at peak flight were mainly the first generation. Based on developmental rates from Turner and Pollard (1959) there were enough growing degree days experienced at most sites for *G. versuta* to have developed from an egg to adult between the first observation in traps until the peak number observed in traps.

Early season transmission of *X. fastidiosa* is of greatest concern because a higher proportion of vectors are infective, and also because an early introduction of *X. fastidiosa* allows for more time in the growing season for bacterial colonies to proliferate within xylem vessels and a greater probability of chronic infection leading to vine death (Purcell 1981). As of yet, the best management practice for growers is

Table 1. Sharpshooters (xylem-feeding Cicadellidae) by subfamily captured in yellow sticky traps (1 m height) in *V. vinifera* vineyards, total number of individuals trapped by year and % of that total by year.

Subfamily	Species	2006		2007	
		Total	% of total	Total	% of total
Cicadellinae	<i>Cuerna</i> spp.**	1	0.01	0	0.00
	<i>Draeculacephala</i> spp.*	13	0.11	9	0.06
	<i>Graphocephala</i> <i>coccinea</i> (Forster)**	72	0.61	60	0.39
	<i>Graphocephala</i> <i>versuta</i> (Say)*	9719	82.81	12924	84.67
	<i>Homalodisca</i> <i>insolita</i> (Walker)*	0	0.00	3	0.02
	<i>Oncometopia</i> <i>orbona</i> (Fabr.)*	811	6.91	401	2.63
	<i>Paraulacizes</i> spp.	61	0.52	36	0.24
	<i>Sibovia</i> spp.	2	0.02	3	0.02
Agallinae	<i>Agallia</i> spp.	485	4.13	698	4.57
Aphrodinae	<i>Aphrodes</i> spp.	2	0.02	7	0.05
Deltocephalinae	<i>Colladonus</i> spp.	12	0.10	8	0.05
	<i>Osbornellus</i> spp.	20	0.17	42	0.28
	<i>Paraphlepsius</i> spp.**	284	2.42	163	1.07
	<i>Penthimia</i> <i>americana</i> (Fitch)	1	0.01	4	0.03
	<i>Scaphytopius</i> spp.	147	1.25	589	3.86
Coelidinae	Unknown	69	0.59	165	1.08
Gyponinae	Unknown	38	0.32	152	1.00

* documented Pierce's disease vector.

** potential Pierce's disease vector (documented to carry *Xylella fastidiosa* but transmission not confirmed).

removal of infected vines in the fall and the use of insecticides to protect vines from bud break through early summer, particularly following one or more mild winters (Gubler et al. 2006).

Acknowledgments

A great deal of thanks goes to participating vineyard managers, extension agents, and colleagues who collaborated in collecting insect traps. Thanks to Eric Day and Curt Laub for their technical support. Thanks to Tony Wolf, Jerry Williams, Tom Kuhar, and Troy Anderson for their

Table 2. Mean total (\pm SE) of *G. versuta* and *O. orbona* collected during the trapping period at peak capture, as well as the mean number (\pm SE) of growing degree days (GDD) accumulated by the beginning of that trapping period in 2006 and 2007.

Species	mean total at peak		mean GDD at peak	
	2006	2007	2006	2007
<i>G. versuta</i>	474.6 \pm 167.2	642.0 \pm 190.0	1437.0 \pm 83.8	1558 \pm 212.5
<i>O. orbona</i>	40.3 \pm 13.5	21.4 \pm 6.5	799.0 \pm 70.0	868 \pm 66.7
t	2.58	3.26	5.84	3.1
df	9, 9.11	9, 9.02	9, 17.44	9, 10.75
p	0.0146	0.0049	< 0.0001	0.0052

Significant difference determined by Student's *t*-test using JMP (*n* = 10).

help in reviewing this manuscript and for their useful suggestions. This research was partially funded by the Virginia Vineyard Association.

References Cited

Almeida, J. R. S. and A. H. Purcell. 2003. Transmission of *Xylella fastidiosa* to grapevines by *Homalodisca coagulata* (Hemiptera: Cicadellidae). J. Econ. Entomol. 96: 265-271.

Almeida, J. R. S. and A. H. Purcell. 2006. Patterns of *Xylella fastidiosa* colonization on the precibarium of sharpshooter vectors relative to transmission to plants. Ann. Entomol. Soc. Am. 99: 884-890.

Feil, H. and A. H. Purcell. 2001. Temperature-dependent growth and survival of *Xylella fastidiosa* in vitro and in potted grapevines. Plant Dis. 85: 1230-1234.

Frazier, N. W. and J. H. Freitag. 1946. Ten additional leafhopper vectors of grape as determined by insect transmission. Phytopathology 36: 634-637.

Freitag, J. H. 1951. Host range of the Pierce's disease virus of grapes as determined by insect transmission. Phytopathology 41: 920-932.

Freitag, J. H. and N. W. Frazier. 1954. Natural infectivity of leafhopper vectors of Pierce's disease virus of grape in California. Phytopathology 44: 7-11.

Gubler, W.D., R.J. Smith, L.G. Varela, J.J. Stapleton, G.M. Leavitt and A.H. Purcell. 2006. UC IPM Pest Management Guide: Grape. UNC ANR Publication 3448.

Hopkins, D. L. 1989. *Xylella fastidiosa*: Xylem-limited bacterial pathogen of plants. Annu. Rev. Phytopathol. 27: 271-290.

Mizell III, R. F. and W. J. French. 1987. Leafhopper vectors of phony peach disease: Feeding site preference and survival on infected and uninfected peach, and seasonal response to selected host plants. J. Entomol. Sci. 22: 11-22.

Myers, A. L., T. B. Sutton, J. A. Abad and G. G. Kennedy. 2007. Pierce's disease of grapevines: Identification of the primary vectors in North Carolina. Phytopathology 97: 1440-1450.

Newman, K. L., R. P. P. Almeida, A. H. Purcell and S. E. Lindow. 2003. Use of a green fluorescent strain of analysis of *Xylella fastidiosa* colonization of *Vitis vinifera*. Appl. Environ. Microbiol. 69: 7319-7327.

Purcell, A. H. 1981. Pierce's disease. Grape Pest Management. Publication No. 4102, Division of Agricultural Sciences, University of California: 62-69.

- Purcell, A. H. and A. H. Finlay. 1979.** Evidence for non-circulative transmission of Pierce's disease bacterium by sharpshooter leafhoppers. *Phytopathology* 69: 393-395.
- Purcell, A. H., A. H. Finlay and D. L. McLean. 1979.** Pierce's disease bacterium: Mechanism of transmission by leafhopper vectors. *Science* 206: 839-841.
- SAS Institute Inc. 2007.** JMP User's Guide. Cary, NC: SAS Institute Inc.
- Severin, H. H. P. 1949.** Transmission of the virus of Pierce's disease by leafhoppers. *Hilgardia* 19: 190-202.
- Severin, H. H. P. 1950.** Spittle insect vectors of Pierce's disease virus. II. Life histories and virus transmission. *Hilgardia* 19: 357-382.
- Stevenson, J. F., M. A. Matthews and T. L. Rost. 2005.** Grapevine susceptibility to Pierce's disease II: Progression of anatomical symptoms. *Am. J. Enol. Vitic.* 55: 238-245.
- Raju, B. C. and A. C. Goheen. 1981.** Relative sensitivity of selected grapevine cultivars to Pierce's disease bacterial inoculations. *Am. J. Enol. Vitic.* 32: 155-158.
- Turner, W. F. and H. N. Pollard. 1959.** Life histories and behavior of five insect vectors of phony peach disease. U. S. Dept. Agric. Tech. Bull. 1188.
- Wallingford, A. K., S. A. Tolin, A. L. Myers, T. K. Wolf and D. G. Pfeiffer. 2007.** Expansion of the range of Pierce's disease in Virginia. Online. *Plant Health Prog.*, doi: 10.1094/PHP-2007-1004-01-BR.